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Studies on effect of media composition and biofertilizer inoculants on seedling growth and seedling vigour of tamarind (*Tamarindus indica* L.)

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ABSTRACT : A pot experiment was conducted to study the effect different media and biofertilizers in combination on seed germination and seedling growth of tamrrind. The maximum seed germination (97.78 %), minimum number of days (7 days) taken for initiation of germination, seedling height (43.53 cm), seedling girth (2.00 cm), number of leaves (46.62), root length (46.67 cm), fresh and dry weight of shoots(23.03 g and 8.25 g, respectively), fresh and dry weight of roots(9.89 g and 5.07 g, respectively), vigour index-I (8811.01) and vigour index-II (1304.61) was recorded in treatment combination of revised potting mixture + cocopeat + *Glomus mosseae* at 150 days after sowing While, control has recorded minimum values for all the characters except number of days taken for initiation of germination.

KEY WORDS : *Glomus mosseae*, Cocopeat and Vigour index

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Tamarind (*Tamarindus indica* L.) is a member of dicotyledonous family Fabaceae and belongs to the sub family Caesalpinoideae. It is a diploid species with chromosome number 2n= 24 (Purseglove, 1987). The name of tamarind is derived from an Arabic word “Tamarind- E- Hind” meaning “Date of India” popularly known as “Indian date”. Tamarind is a short trunked, multistemmed, large, evergreen or semi-evergreen tree growing up to 30 m with a trunk of about 8 m circumference and a crown diameter of up to 12m. Tamarind trees starts bearing the fruits at the age of 13 to 14 years and continue to produce fruits even after 60 years and some up to 200 years. Tamarind half the pod weight is contributed by pulp. Pulp contains both sugars (30-40%) and organic acids (8-18%), predominantly tartaric acid. The pulp is also a rich source of vitamins, minerals and calcium.

The pulp is widely used as a spice for souring curries, chutneys and certain beverages. Tamarind is native of the Dry Savanna of Tropical Africa and probably some parts of South India. It is cultivated throughout the tropics and subtropics of the world and has become naturalized at many places. India is the main producer and consumer of tamarind in the world. It is estimated that India produces 3 million tons of fruits and exports the tamarind products worth of Rs. 50 cores per annum (Kotech and Kadam, 2002).

Tamarind is traditionally propagated from seed; tamarind produces relatively large seeds that average about 11-12.5 mm in diameter. They are flattish, shiny brown to blackish, with a hard impermeable seed coat. Germination of tamarind seed is epigeal**.** On an average, tamarind seeds begin to germinate about 13 days after sowing but may take a month to complete

(Jøker, 2000). The main disadvantage of seed propagation is freshly harvested seeds of tamarind exhibit poor germination percentage even if exposed to favorable conditions of germination owing to seed dormancy. It may be due to morphological factor such as hard, thick testa or due to incorrect storage or handling (secondary dormancy). Bio-fertilizers, *viz*., *Azotobacter*, *Azospirillum*, phosphate solubilizing bacteria and vesicular arbuscular mycorrhiza fungi (VAM) improve the seed germination and seedling growth through producing several growth regulators substances like indole acetic acid (IAA), gibberlic Acid (GA) and vitamins besides fixation of atmospheric nitrogen (Fallick *et al*., 1989; Ruan *et al*., 1973) and usage of nitrogen fixers and phosphorus solubilizers are known to improve the quality of soil.

The present day nursery practices involve higher cost and risks with respect to raising of seedling rootstocks and their subsequent maintenance until they attain the graftable size. Healthy growth of rootstock is most important in attaining the higher rate of grafting success. In the nursery activities, the preparation of media and use of growth regulators, biofertilizers should receive the considerable attention of the nursery men and growers for improving germination and subsequent growth of seedlings. Though tamarind is economically an important fruit crop of India, very little work has been done on raising of seedling rootstocks.

RESEARCH METHODS

The present investigation was carried out at Regional Horticultural Research and Extension Centre, University of Horticultural Sciences, Gandhi Krishi Vignyan Kendra (West), Bangalore, during 2012-2013. The experimental field is located at an altitude of 930 meters above mean sea level 12°58' North latitude and 77^{0}35' longitude Bettahalli Layout, Vidyaranyapura, Bengaluru during the period 2012-13.

The experimental design selected was Completely Randomized Design. Sixteen different treatments were imposed including control. Fifteen seeds were used for each treatment, which was replicated thrice. The seeds were sown in the polythene bag containing different media and biofetilizers in combination as T_1-Regular potting mixture *i.e.*, red earth, FYM, sand (2:1:1), T_2-Regular potting mixture + cocopeat (1:1) , T_3-Regular potting mixture + *Azatobacter,* T_4-Regular potting mixture + *Glomus mosseae*, T_5-RPM + *Pseudomonas fluorescens* , T_6-RPM + cocopeat + *Azatobacter,* T_7-RPM + cocopeat + *Glomus mosseae* , T_8-RPM + cocopeat + *Pseudomonas fluorescens,* T_9-Revised potting mixture *i.e.* red earth, vermicompost, sand (2:1:1), T_{10}-RPM + cocopeat (1:1) , T_{11}-RPM + *Azatobacter,* T_{12} RPM + *Glomus mosseae,* T_{13}-RPM + *Pseudomonas fluorescens,* T_{14}-RPM + cocopeat + *Azatobacter,* T_{15}-RPM + cocopeat + *Glomus mosseae* and T_{16} - Rpm + cocopeat + *Pseudomonas fluorescens* and were kept in the shade house. The polythene bags were watered daily till final data were recorded. Observations were recorded daily on germination parameters and monthly for vegetative parameters like plant height, number of leaves, stem girth, fresh weight, dry weight by keep the seedlings in hot air oven at the temperature of 60^0 C till constant weight was attained and seedling vigour for up to 150 days after sowing. The data collected from the five labelled seedlings in each treatment were averaged and completely randomised design (CRD) was employed to find out the significance among different treatments with the help of 'F' test (Sunderaraju *et al*., 1972). The seedling vigour was calculated based on the following formulas (Bewley and Black, 1982).

Vigour index – I (cm) = Mean seedling length x per cent germination

Vigour index – II (g) = Dry weight of seedling x per cent germination

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarised under following heads:

Seed germination characters:

Pre-sowing treatments influenced germination characters of seeds, resulting in their improved germination (Table 1).

The highest germination (97.78 %) and earliest germination (7 days) was recorded with revised potting mixture + cocopeat + *Glomus mosseae* media treatment (T_{15}). The late germination was noticed in control, which took 10.33 days for initiation of germination. The reason for highest seed germination may be due to the influence of cocopeat, it might have helped the media to acquire good physical and chemical properties by decreasing compactness and increasing the porosity of the medium, *Glomus mosseae* fungi attributed to creating favourable condition such as, optimum moisture retention, temperature, secretions of vitamins, growth promoting substances and water absorption. The results are in line with those obtained by Thoke *et al*. (2011) in jamun. The reason for early initiation of germination may be due to the influence of cocopeat, it might have helped the media to acquire good physical and chemical properties by decreasing compactness and increasing the porosity of the medium, *Glomus mosseae* fungi attributed to creating favourable condition such as, optimum moisture retention, temperature, secretions of vitamins, growth promoting substances and water absorption. Hard seed coat which is impermeable to water and oxygen (Bewley and Black, 1982). By the influence of cocopeat and *Glomus mosseae* increased the permeability of air and water through seed which favors the earliest germination.

Vegetative characters:

Pre-sowing treatments influenced vegetative characters

of seedling, resulting in their improved growth and development of seedling (Table 1).

The treatments effect on plant height indicated that at all stages of plant growth 60, 90, 120 and 150 days after sowing the treatment which revised potting mixture + cocopeat + *Glomus mosseae* (T_{15}) recorded maximum plant height (43.53 cm), maximum collar girth (2.00 cm) and maximum number of leaves (46.62) at 150 days after sowing. The minimum values recoreded for all the characters in control. The reason for getting maximum plant height and collar girth in medium of revised potting mixture (2:1:1) + cocopeat + *Glomus mosseae* (T_{15}) may be due to combined effect of potting mixture, cocopeat and *Glomus mosseae* fungi. Cocopeat along with red earth, FYM and sand, provided good media mixture for plant growth. It served as nutrient source, helped in providing good physical and chemical characteristics to media. The growth in the form of plant height was recorded where cocopeat and *Glomus mosseae* was used. *Glomus mosseae* helps in uptake of nutrients like P, Zn, Cu, Fe and or due to the production of growth promoting substances. It also helps in water uptake and maintains good physical property of soil. The influence of media component was due to the combined effect of the entire component used in media, and such component favoured the plant growth in its own way. These results are in conformity with the those of Bhosale *et al*. (2008), in tamarind. It is reported that, FYM contains significant amount of ammonium and nitrate that are readily available to crops. It is also reported that FYM supported higher density of microbial biomass, soil aggregation, organic carbon, and total nitrogen apart from improving the quality and growth of crops (Agele *et al*., 2005).

The reason for the best performance of treatment of revised potting mixture (2:1:1) + cocopeat + *Glomus mosseae* could be due to combined effect of red earth, vermicompost, sand, cocopeat and *Glomus mosseae* with good drainage qualities of the medium. The cocopeat portion of the medium helped in meeting immediate requirement of nutrients, along with availability of balanced nutrition and optimum quantity of VAM that is *Glomus mosseae* which is required for proper colonization. Application of VAM helps in nutrient and water uptake and also maintenance of good physical and chemical properties of the media. Similar differences in seedling girth were reported by Kumar *et al*. (1998) in cashew.

The probable reason for maximum number of leaves in case of treatment revised potting mixture + cocopeat + *Glomus mosseae* may be due to the influence of proprietary compound might have decomposed and released nutrients which helps in production of more number of leaves. It is evident from the results that cocopeat and *Glomus mosseae* in medium combination had helped in the better growth of seedlings.

Table 1 : Effect of media and biofertilizers on germination and seedling growth parameters of tamarind

Treatments	Initiation of seed germination (days)	Germination percentage	Seedling height (cm)				Seedling collar girth (cm)				Number of leaves per plant			
			60 DAS	90 DAS	120 DAS	150 DAS	60 DAS	90 DAS	120 DAS	150 DAS	60 DAS	90 DAS	120 DAS	150 DAS
T_1	10.33	84.44	16.44	19.27	24.20	29.20	0.66	1.02	1.23	1.45	7.73	14.07	25.50	32.10
T_2	8.00	88.88	16.54	20.51	25.01	34.23	0.84	1.18	1.42	1.72	9.93	18.93	29.40	37.47
T_3	9.33	88.88	17.07	21.08	27.08	34.30	0.84	1.14	1.35	1.68	9.00	16.17	28.52	36.70
T_4	8.67	91.11	16.28	21.57	28.50	38.41	0.92	1.25	1.62	1.90	9.50	16.40	30.93	39.31
T_5	9.00	88.88	16.59	22.27	25.27	30.20	0.81	1.15	1.42	1.80	8.67	16.00	28.33	35.50
T_6	8.67	86.66	16.39	21.52	28.50	37.90	0.86	1.25	1.46	1.70	9.60	16.47	31.84	37.80
T_7	7.33	95.55	18.70	23.05	30.10	41.24	0.94	1.27	1.64	1.90	11.34	20.67	33.44	40.80
T_8	8.33	88.88	14.67	18.91	26.00	32.60	0.86	1.19	1.47	1.80	9.50	16.13	30.80	35.35
T_9	8.00	91.11	18.45	23.33	27.33	34.11	0.74	1.18	1.39	1.79	10.00	16.80	26.71	34.57
T_{10}	7.33	93.33	16.77	21.23	26.30	35.30	0.86	1.22	1.51	1.80	10.25	16.93	26.30	37.40
T_{11}	8.67	91.11	17.57	21.86	29.90	32.21	0.85	1.17	1.42	1.76	10.33	16.40	30.51	35.62
T_{12}	8.67	93.33	15.17	21.96	30.27	39.53	0.90	1.29	1.63	1.95	9.60	22.20	32.45	40.86
T_{13}	9.00	91.11	16.60	20.27	27.06	33.60	0.82	1.16	1.48	1.72	9.27	20.53	30.48	37.20
T_{14}	8.00	88.88	17.57	22.65	29.60	41.17	0.83	1.15	1.35	1.75	10.60	19.87	33.27	43.54
T_{15}	7.00	97.78	18.94	25.05	32.60	43.53	0.96	1.34	1.69	2.00	11.77	21.60	37.30	46.62
T_{16}	9.00	86.66	17.43	22.23	27.10	37.80	0.82	1.12	1.57	1.86	8.27	16.40	29.98	36.67
F test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
S.E.±	0.47	2.35	0.63	0.86	1.22	1.61	0.03	0.05	0.05	0.08	0.72	1.01	1.55	1.47
C.D. (P=0.05)	1.37	6.79	1.82	2.49	3.52	4.66	0.10	0.14	0.16	0.23	2.09	2.91	4.47	4.24
CV	9.19	4.23	6.05	6.48	7.15	7.30	6.76	6.97	6.41	7.35	12.13	9.19	8.30	6.30

*=Significant

Similar observations on number of leaves were observed by Devachandra *et al*. (2008) in jamun.

The treatment with revised potting mixture + cocopeat + *Glomus mosseae* media (T_{15}) had recorded highest vigour index-I (8811.01) and vigour index-II (1304.61). This was significantly superior over all other treatments. The lowest vigour indix-I (4972.18) and vigour index-II (520.90) was noticed in control (Table 2).

The reason for highest seedling vigour may be due to cocopeat portion of the medium helped in meeting immediate requirement of nutrients, along with availability of balanced nutrition and optimum quantity of *Glomus mosseae*, which is required for proper colonization. Application of *Glomus mosseae* helps in nutrient and water uptake and also maintenance of good physical and chemical properties of the media.

Fresh and dry weight of shoots:

Fresh and dry weight of shoots showed (Table 2) significant difference among the treatments. Revised potting mixture + cocopeat + *Glomus mosseae* media (T_{15}) had recorded higher fresh and dry weight of shoots (23.03 g and 8.25 g, respectively). While the minimum fresh weight and dry weight of shoots (12.00 g and 3.87g, respectively) was found in the control (T_1). The maximum fresh and dry weight which is mainly due to the application of cocopeat and VAM that is *Glomus mosseae* increases the water holding capacity and release of available nutrients to the growing plant which increases the production of auxin, gibberellins, cytokinins and hence, inoculated roots had larger proportion of younger roots and root elongation resulting in increased size and number of hairs.

Roots characters:

Maximum root length (46.67 cm) was noticed (Table 2) with the revised potting mixture + cocopeat + *Glomus mosseae* media (T_{15}). The minimum of 29.67 cm was recorded in the control treatment (T_1). The increase in root length may be due to the production of hydrolic enzymes that release nutrients in basal media, production of natural chelates to enhance nutrient uptake and enhanced root systems. In similar studies, vesicular arbuscular mycorrhiza (*Glomus mosseae*) fungi enhanced the root growth, biomass and nutrient uptake of black pepper (Bopaiah and Khader *et al*., 1989; Kandiamman *et al*., 2000).

Fresh and dry weight of roots showed (Table 2) significant difference among the treatments. Revised potting mixture + cocopeat + *Glomus mosseae* media (T_{15}) had recorded higher fresh and dry weight of roots (9.89 g and 5.07 g, respectively). While, the minimum fresh weight and dry weight of roots (5.20g and 2.27g, respectively) was found in the control (T_1).

The maximum fresh and dry weight it is mainly due to the application of cocopeat and VAM that is *Glomus mosseae*

Table 2 : Effect of media and biofertilizers on seedling biomass, root length, vigour and days taken to attain graftable size in tamarind

Treatments	Fresh weight shoot (g)	Fresh weight root (g)	Dry weight shoot (g)	Dry, weight root (g)	Root length (cm)	Vigour index 1	Vigour index 2	Number of days taken to attain graftable size
T_1	12.00	5.20	3.87	2.27	29.67	4972.18	520.90	207.60
T_2	16.78	7.17	6.00	3.13	33.67	6041.40	811.50	183.46
T_3	15.90	7.33	5.20	3.33	36.67	6328.51	758.17	186.26
T_4	21.63	8.17	7.07	4.20	41.67	7289.42	1026.77	163.73
T_5	15.87	6.47	5.10	2.67	32.67	5584.09	691.07	175.13
T_6	16.10	7.58	5.80	3.60	37.33	6519.72	814.60	188.77
T_7	21.97	8.58	7.20	4.31	43.60	8136.27	1099.82	165.00
T_8	17.60	7.35	6.00	3.37	36.00	6086.28	832.84	175.13
T_9	16.80	6.50	5.89	2.90	32.33	6062.15	800.83	178.13
T_{10}	19.53	7.00	6.93	3.00	35.67	6645.86	926.77	173.13
T_{11}	16.30	7.55	5.70	3.90	37.58	6366.32	874.62	180.17
T_{12}	22.90	8.45	7.60	4.28	41.67	7577.51	1108.76	161.00
T_{13}	18.07	6.68	6.00	2.96	32.87	6052.59	816.32	182.70
T_{14}	22.30	7.65	7.73	3.80	37.95	7036.67	1024.82	177.20
T_{15}	23.03	9.89	8.25	5.07	46.67	8811.01	1304.61	157.07
T_{16}	17.86	7.85	6.00	3.93	38.16	6582.69	860.53	170.00
F test	*	*	*	*	*	*	*	*
S.E.±	0.92	0.45	0.40	0.20	2.63	386.55	50.82	7.26
C.D. (P=0.05)	2.66	1.31	1.17	0.59	7.57	1113.54	146.40	20.92
CV	8.14	9.93	10.57	9.44	11.49	9.46	9.25	6.68

*=Significant

increases the water holding capacity and release of available nutrients to the growing plant which increases the production of auxin, gibberellins, cytokinins and hence inoculated roots had larger proportion of younger roots and root elongation resulting in increased size and number of hairs.

Number of days taken for attaining graftable size:

The reason for the less number of days taken for attaining graftable size by treatment of revised potting mixture (2:1:1) + cocopeat + *Glomus mosseae* could be due to combined effect of red earth, vermicompost, sand, cocopeat and *Glomus mosseae* with good drainage qualities of the medium. The cocopeat portion of the medium helped in meeting immediate requirement of nutrients, along with availability of balanced nutrition and optimum quantity of VAM that is *Glomus mosseae*, which is required for proper colonization. Application of VAM helps in nutrient and water uptake and also maintenance of good physical and chemical properties of the media, under the influence of media with VAM might have attributed for increase in photosynthetic activity accelerated the utilization of photosynthetic products which enhanced the growth and stem girth for attaining graftable size.

Conclusion:

From the present investigation, it is concluded that the media consisting of revised potting mixture + cocopeat + *Glomus mosseae* recorded the maximum seed germination per cent, decrease in number of days taken for initiation of germination. Seedling height, seedling girth, seedling leaves at 60, 90,120 and 150 days after sowing was maximum in the same treatment as revised potting mixture + cocopeat + *Glomus mosseae* media. Root length, fresh weight, dry weight and vigour index-I (cm), vigour index-II (g) at the end of experiment were maximum in revised potting mixture + cocopeat + media whereas, minimum values for all the characters was recorded in control.

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